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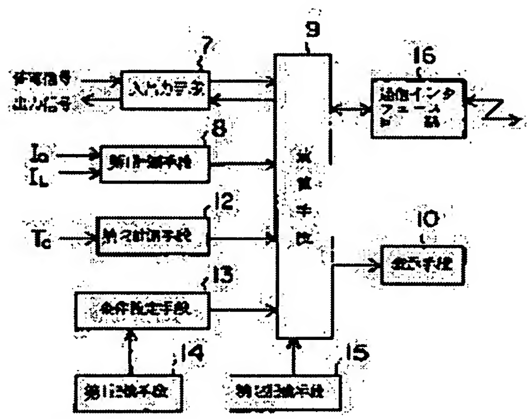
(54) CAPACITY AND RESIDUAL TIME INDICATOR OF STORAGE BATTERY

(57)Abstract:

PURPOSE: To provide a device having wide use for detecting storage battery current in a direct current supply power system and estimating and indicating a residual capacity and a discharge time.



CONSTITUTION: A condition setting means 13 can be initially set in accordance with operation conditions by a first memory means 14 for storing a specification setting data table of a rectifier 1 and a storage battery 2. An operation means 9 has a first measurement means 8 for measuring storage battery current and a second measurement means 12 for measuring temperature. And, discharge coefficient for discharge current is found and a quantity of discharge is calculated from a second memory means 15 for detecting the discharge current and the temperature at the time of operation and storing the discharge coefficient for converting them into a specified time-rate discharge. Subtraction is successively performed from a capacity at the time of full charge of an initial value at the time, residual capacity is divided by the discharge current and the discharge coefficient, and a residual discharge time is estimated. In addition, a display 10 for indicating an operation result is equipped.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention presumes the remaining capacity and the discharge remaining time of a battery in the direct-current electric supply system which consists of a rectifier and a battery and supplies power to a load, and relates to the display which displays the value.
[0002]
[Description of the Prior Art] It is the output current I0 of the rectifier 1 with which the direct-current electric supply system which drawing 7 consists of a rectifier and a stationary battery, and supplies power to a load is shown, and the charge and discharge current I of a battery 2 is detected by the shunt 4. It is obtained by searching for a difference with the current IL of the load 3 detected by the shunt 5. The remaining capacity of a battery 2 can be known by measuring these two shunt currents for every unit time amount with capacity and the remaining time display 6, and calculating them. The example of a circuit of the conventional capacity and remaining time display 6 (it is called display for short below) is shown in drawing 8 . In drawing 8 , the I/O means 7 are the circuit which inputs the interruption-of-service signal and failure signal from a rectifier 1, and a circuit which outputs an equalized charge signal and an alarm signal to a display 6. The measurement means 8 can read the detecting signal from said shunts 4 and 5 with an A/D converter, and can calculate remaining capacity by calculating in quest of difference with the operation means 9. Moreover, it is the load current IL detected from a shunt 5 in said remaining capacity when the I/O means 7 detects an interruption-of-service signal. By doing a division, the discharge remaining time at the time can be found. And this remaining capacity and the discharge remaining time are displayed with the display means 10, such as LCD and LED.
[0003]
[Problem(s) to be Solved by the Invention] However, it measures with the measurement means 8 shown in drawing 2 , and depends only on the magnitude of the battery discharge current for the amount of discharge per [which is obtained by the operation means 9] unit time amount. That is, in an actual direct-current electric supply system, with the magnitude of the voltage drop of the battery 2 and load 3 which are shown in drawing 7 , the battery permission minimum electrical potential difference may be unable to change, either, and rated capacity may be unable to be discharged 100%. Moreover, it is known that a discharge property changes with discharge rates remarkably, and temperature dependence of a battery is [this discharge property] large. Therefore, the approach only by the magnitude of the discharge current has the problem that the effect an error affects the backup activity of emergency greatly is large. This invention tends to solve these troubles and tends to aim at improvement in the remaining capacity of a battery, and the presumed precision of the discharge remaining time.
[0004]
[Means for Solving the Problem] The I/O means which this inventions are a rectifier and the display of the direct-current electric supply system which supplies power to a load from a battery, and outputs and inputs a signal between said rectifiers, In the capacity and the remaining time display of the battery equipped with a 1st measurement means to measure the output current and the load current of said rectifier, and an operation means to search for a battery current from the difference of the output current and the load current which were calculated with this 1st measurement output A

2nd measurement means to measure the case temperature of said battery, and a 1st storage means to memorize the table data which collected the specification setting items and the set points of said rectifier and a battery, The conditioning means which chooses from said 1st storage means and can be set up according to actual employment conditions, The capacity conversion time amount (K) and the charging-time-value (T) property which were set to the predetermined specification of a battery are used. A 2nd storage means to memorize the battery whose rated capacity is known as table data in quest of the discharge multiplier to the discharge current (C-Rate) at the time of discharging, It asks for the discharge multiplier corresponding to the discharge current and temperature of a battery which were measured for every unit time amount more fixed than said 1st measurement means and the 2nd measurement means with said 2nd storage means. The amount of discharge which multiplied the value by said discharge current and unit time amount, and was converted into the predetermined rate discharge of time amount is computed. Carry out sequential subtraction of said amount of discharge from the battery rating which makes a full charge initial value, and remaining capacity is calculated. The percentage to a full charge is computed, and the division of said remaining capacity is done by said discharge multiplier and the discharge current at the time, and it has an operation means to presume the discharge remaining time in an operating condition, and a display means to update and display the result of an operation for every unit time amount of measurement.
[0005]
[Example] Drawing 1 is the example which used the display 60 by this invention for the direct-current electric supply system shown in drawing 7 , and has detected the case temperature of a battery with the temperature sensor 11. It aims at drawing 2 R> 2 adding the 2nd measurement means 12, the conditioning means 13, the 1st storage means 14, the 2nd storage means 15, and the communication-interface circuit 16 to the block diagram of the conventional indicating equipment 6 which showed the circuitry of the equipment 60 by this invention, and was shown in drawing 8 , enabling loading of an indicating equipment 60 in the rectifier with which rating differs with improvement in the remaining capacity at the time of discharge, and the presumed precision of the discharge remaining time, and attaining wide use. In addition, in order to distinguish the measurement means 8 shown in drawing 8 from the 2nd measurement means 12 in drawing 2 , it was indicated as the 1st measurement means 8. Each function of drawing 2 is explained below.
[0006] The 2nd measurement means 12 is amplified when the detecting signal of a temperature sensor 11 is a voltage signal, and in the case of an impedance signal, after changing into a voltage signal, the temperature of the charge-and-discharge condition of a battery 2 is supervised in the measurement circuit which carries out A/D conversion. The conditioning means 13 is the circuit section which sets up the alarm level which battery remaining capacity decreases and performs alarm-output actuation while setting up each value of the rated value of the shunts 4 and 5 employed by the system shown in drawing 1 , battery classification, rated capacity, and the permission minimum electrical potential difference. Since these set points are set up according to the situation of a site, versatility can apply high very broadly.
[0007] For example, the rated current value of the shunt 4 shown in drawing 1 is determined with the rated capacity of a rectifier 1 with the value adding the discharge current of a battery 2, and the current to a load 3, and the rated value of a shunt 5 is determined in the magnitude of the load current. Therefore, battery rated capacity is determined by the time amount by which the maximum load current detected with said shunt 5 is held at the time of interruption of service. Thus, it is very effective that the conditioning means 13 which can be set up with a key switch, a drop, etc. is established according to the setups of the system to diversify, and it can initialize easily at the time of actuation. And as shown in drawing 2 , according to this set-up value, the value read with the 1st measurement means 8 is converted by the operation means 9, and turns into an actual measurement. The 1st storage means 14 are setting data tables, such as a value of the selectable range for every setting item of said conditioning means 13, or a rated display, and are usually memorized by ROM. After being chosen by said conditioning means 13 and set up, it is written in RAM of a non-volatile etc. and held.
[0008] The 2nd storage means 15 is the data table in which being prepared for for every battery classification and showing the relation of the discharge current (C-Rate) and the discharge multiplier alpha to rated capacity by making the permission minimum electrical potential difference of a

battery, and temperature into a parameter. This data table is what subdivided and table-ized the discharge current (C-Rate) and the discharge multiplier property which were shown in drawing 3 , and is usually memorized by ROM by making the permission minimum electrical potential difference and case temperature of a battery into a parameter. The discharge multiplier alpha of drawing 3 is a discharge multiplier which expresses the severity of discharge conditions to the known rated capacity (rate discharge capacity [in / usually / 25 degrees C] of 10 time amount) which the discharge current measured with the shunt 5 and the 1st measurement means 8 installed, and becomes so large that temperature is so low that a discharge rate and the permission minimum electrical potential difference are large on the contrary. This property is in agreement with the inclination which the discharge characteristic curve of a battery shows.

[0009] Next, the calculation approach of the property of drawing 3 which serves as an important basis when presuming the remaining capacity of this invention is described. It is usually called a K-T curve, is prepared for every battery temperature with the classification of a battery, the property shown in drawing 4 is an example of the standard property Fig. of the capacity conversion time amount K of the Japanese battery Semiconductor Equipment & Materials International specification SBA6001 "the capacity computing method of a stationary battery", and a charging time value T, if K value corresponding to the charging time value to need is multiplied by the discharge current, it can calculate required rated capacity (10HR) easily, and generally it is used well. Drawing 3 uses the K-T standard property shown in this drawing 4 , and plots as follows.

[0010] When the battery rating is determined and the fixed discharge current is passed, 10H of the charging time value T of the axis of abscissa shown in drawing 4 are expressed as discharge current 0.1C equivalent to the rate discharge of 10 time amount (10HR). It is drawing 3 which calculated the value which did the division of the capacity conversion time amount K of the axis of ordinate of drawing 4 at this time (about 10 H) by charging-time-value 10H of an axis of abscissa as a discharge multiplier alpha, asked for similarly about other charging time values, and was graph-ized. As the discharge current shows the discharge pattern of drawing 5 by said specification SBA6001, they are CI, CII, and CIII. When it changes, the battery rating C required for the whole discharge is given by (1) type.

[0011]

[Equation 1]

C=CI +CII+CIII =K1 I1 +K2 (I2 -I1)+K3 (I3 -I2) (1)

[0012] Namely, the discharge current I1, I2, and I3 It is I1 of the 1st term to a change pattern that a battery rating is directly related to the magnitude of the discharge current. By the 2nd term and the 3rd term, the difference of (I2-I1) and (I3-I2) is related. Therefore, if change of a discharge pattern is not known, generally a required capacity will be determined in consideration of the worst conditions in use of a battery, assuming the magnitude of the discharge current at that time to be fixed, although it cannot determine. Moreover, how to calculate the amount of discharge at the time of making a known capacity discharge using (1) type Charging time value T1 of the initial value shown in the discharge pattern of drawing 5 Since it is unknown Time amount is added for every cycle time which measures the discharge current, and it is a charging time value T1. By this approach, it has complicated count that changing, choosing capacity conversion time amount K value further to compensate for change of the discharge current at that time, and recalculating from the 1st term of (1) type will be repeated, and it is not practical. Then, it asks for the discharge multiplier alpha which converts into C-Rate the discharge current shown in drawing 3 , and corresponds, and it multiplies by unit time amount deltat as the cycle time of the discharge current I and measurement, and the amount of discharge (alphaxIxdeltat) per [which was converted into the rate of 10 time amount (10HR)] unit time amount is calculated. It is the discharge time of day tn of arbitration by carrying out sequential subtraction and repeating this from the initial rated capacity C10 (t0) which converted this amount of discharge into 10HR. The battery remaining capacity C10 (tn) converted into 10HR which can be set can be calculated by (2) types.

[0013]

[Equation 2]

$$C_{10}(t_n) = C_{10}(t_0) - \sum_{i=1}^{n} \alpha_i \times I_i \times \Delta t \qquad (2)$$

[0014] here -- alphai Time of day t0 from -- tn up to -- it is the value determined with the discharge current Ii which is the discharge multiplier of the arbitration of a between and is a measurement value at this time, battery temperature, and the set-up permission minimum electrical potential difference. Moreover, drawing 3 is subdivided moderately as mentioned above, it collects for every battery classification and temperature, and the data table memorized by the 2nd storage means 15 is discharge multiplier alphai of arbitration. There are few opportunities directly called for from this data table, and, usually it is located in the middle of a table. In such a case, the discharge current Ii A data value before and after being related to the value converted into C-Rate, the permission minimum electrical potential difference, and temperature is selected, the straight-line approximation calculation which connects these points is performed by the operation means 9, and it is optimal discharge multiplier alphai. It asks. Therefore, it can be said that remaining capacity C10 (tn) is sufficiently [in precision] high.
[0015] The remaining capacity (%) to the full charge of C10 (tn) is expressed by (3) types.
[Equation 3]
Remaining capacity (%) =C10(tn)/C10 (t0) (3)
Next, time of day tn of arbitration The discharge remaining time td which can be set It is the discharge current In by (4) types first. It is alphan about the capacity calculated by (2) formulas in order to return to the remaining capacity Cx (tn) in the conditions at the time. A division is done and it asks.
[Equation 4]
Cx =(tn) C10 (tn) / alphan (4)
Next, the discharge current In If a division is done, it is the discharge current In. Time of day tn The discharge remaining time td at the time of assuming that henceforth was continued It can ask by (5) types.
[Equation 5]
td =Cx (tn)/In (5
On the other hand, it is time of day tn. It sets, assumes that interruption of service was recovered, and is time-of-day tn+1 after unit time amount deltat. Change of the remaining capacity C10 (tn+1) which can be set is charging current In+1, as shown in (6) types. Unit time amount deltat is multiplied by it and added.
[Equation 6]
C10(tn+1) =C10(tn)+In+1 xdeltat (6)
[0016] Thus, data processing in the charge and discharge of a battery is performed by the operation means 9 shown in drawing 2 . Even if it starts a charge timer, it compares by deadline and remaining capacity has not reached to 100% after decreasing to less than constant value with the charging current, for example, 0.01 C, in the charge at the time of interruption-of-service recovery since the difference by the count approach of charge and discharge turns into a difference of remaining capacity and it appears, by regarding as 100% of a full charge, it is possible to amend a calculation error and these amendments also carry out with the operation means 9. The remaining capacity and the discharge remaining time which were found by the above are updated to every cycle-time deltat with the display means 10, such as LED, liquid crystal, and EL, and are displayed.
[0017] If the display means of the dot pitch which has resolving power with the sufficient display means 10 to illustrate the situation of change of remaining capacity and the discharge remaining time is used, the locus (thick continuous-line display) of a discharge condition as shown in drawing 6 , and presumption (chain-line display) are illustratable with the command of the operation means 9. The outline shown below at this drawing 6 R> 6 is described. interruption-of-service detection time of day t0 unit time amount deltat as the first after measurement cycle time -- setting -- the discharge current I1 ******** -- the count from (2) types to (5) types -- carrying out -- discharge remaining time td =t4 It can ask for a B point. the discharge current I1 Time of day t1 up to -- the straight line and time of day t1 which connect an A point and a B point since it is fixed The locus of remaining capacity and a charging time value decreases along with the straight line between AC to C point which is an intersection. And time of day t1 It sets and a battery current is I2. The locus at the time of increasing is as follows.
[0018] Time of day t0 The discharge current I1 which can be set In quest of a B point, it is the

discharge current I2 with the same approach. Even if it attaches, when it asks, it is the discharge time of day t2. D point is searched for. the ** which does not change the inclination at this time (t4 / t2) for the straight line which connects between Points A and D -- the discharge current I2 Time of day t1 which is a changing point the point E of carrying out a parallel displacement to C point, and crossing the elapsed time of an axis of abscissa -- time of day t1 the estimate of the new discharge remaining time which can be set -- the last presumed time of day t4 from -- time of day t3 It changes and becomes short. Time of day tx of arbitration It sets and is the discharge current I2. Since it is fixed, F on the straight line which connects Points C and E are asked for remaining capacity C10 (tx). On the other hand, for the discharge remaining time, future is also the discharge current I2. Time of day t3 of E points at the time of assuming that it flows Since progress of through time is not dependent on the magnitude of the discharge current, when it is threshold value, and the parallel displacement of this point is carried out to a straight line CB, it is time of day t1. G points are searched for.

[0019] namely, time of day t1 setting -- the discharge remaining time -- (t4-t1) to (t3-t1) -- rapid -- decreasing -- after that -- time of day tx ****** -- the locus which decreases linearly is shown. Moreover, change of the remaining capacity after that is presumed to be is shown by the chain line which connects Points F and E, and change of the discharge remaining time is shown by the alternate long and short dash line which connects Points H and E. It is time of day tx. It is useful as a man machine interface to have a means to be able to ask similarly even if change of the discharge current occurs also about henceforth, and to plot and display these.

[0020] It is said time of day t1 as an example. Approaches, such as separating the load of the low level of priority one by one according to the significance of a load in the case of the small value which does not reach the holding time which is intuitive and is easier to understand it since change of the rapid remaining time which can be set follows and changes to fluctuation of the load current, for example, the value of the discharge remaining time expects at a certain time of day, are performed. Separation of a load is followed, and the discharge remaining time becomes large and can judge easily whether separation of a load is the need further in one good to as [present condition]. Moreover, it is also easy remaining capacity for the alarm level set up by the conditioning means 13 to presume at which time it reaches.

[0021] Although how to calculate the remaining capacity by this invention is not faithfully based at (1) ceremony of the capacity computing method by specification SBA6001 as stated above, it is effective as the approximation-approach and precision is improving extremely as compared with the calculation approach by the product of the current of the moreover former, and time amount. As mentioned above, it is not proper to discuss the error by (1) type, since it has determined by the holding time which assumed the maximum discharge current of the worst value to be fixed since a discharge pattern generally did not understand the decision of an actual battery rating, and since this invention has moreover taken in the view by said specification SBA6001 by comparatively easy count, it is highly [in precision or] practical. [of this invention]

[0022]

[Effect of the Invention] Whether rating of a rectifier differs so that it can apply to a standard direct-current electric supply system, or battery classification differs from rating, those means that can carry out conditioning are established, it is registered and this invention is held. Moreover, since the measurement value of two currents by shunts 4 and 5 is converted by the ratio defined to the set point and amendment about the classification of a battery, the permission minimum electrical potential difference, a discharge rate, and temperature is performed by the operation means 9, remaining capacity and the precision over a remaining time display are very high. Moreover, if a highly efficient display means is used, an above-mentioned locus and an above-mentioned forecast are also illustratable. Furthermore, by preparing a communication-interface circuit as occasion demands, it is also possible to transmit to the host computer which supervises such information. Therefore, since the function which carries out the monitor of the battery rating to a rectifier is required more often in recent years, it is very useful to carry the display of this invention which has versatility in a direct-current electric supply system.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The I/O means which are a rectifier and the display of the direct-current electric supply system which supplies power to a load from a battery, and outputs and inputs a signal between said rectifiers, In the capacity and the remaining time display of the battery equipped with a 1st measurement means to measure the output current and the load current of said rectifier, and an operation means to search for a battery current from the difference of the output current and the load current which were calculated with this 1st measurement output A 2nd measurement means to measure the case temperature of said battery, and a 1st storage means to memorize the table data which collected the specification setting items and the set points of said rectifier and a battery, The conditioning means which chooses from said 1st storage means and can be set up according to actual employment conditions, The capacity conversion time amount (K) and the charging-time-value (T) property which were set to the predetermined specification of a battery are used. A 2nd storage means to memorize the battery whose rated capacity is known as table data in quest of the discharge multiplier to the discharge current (C-Rate) at the time of discharging, It asks for the discharge multiplier corresponding to the discharge current and temperature of a battery which were measured for every unit time amount more fixed than said 1st measurement means and the 2nd measurement means with said 2nd storage means. The amount of discharge which multiplied the value by said discharge current and unit time amount, and was converted into the predetermined rate discharge of time amount is computed. Carry out sequential subtraction of said amount of discharge from the battery rating which makes a full charge initial value, and remaining capacity is calculated. An operation means to compute the percentage to a full charge, and to do the division of said remaining capacity to said discharge multiplier by the discharge current at the time, and to presume the discharge remaining time in an operating condition, The capacity and the remaining time display of the battery characterized by providing a display means to update and display the result of an operation for every unit time amount of measurement.
[Claim 2] The capacity and the remaining time display of the battery according to claim 1 which is the display means which can make the result of an operation a locus and can carry out a graphic display while said display means updates and displays the result of an operation by said operation means for every unit time amount of measurement.
[Claim 3] The capacity and the remaining time display of the battery according to claim 1 or 2 which equipped the measurement value list by said 1st and 2nd measurement means with the communication-interface circuit for transmitting the operation data based on said operation means outside.

[Translation done.]

DESCRIPTION OF DRAWINGS

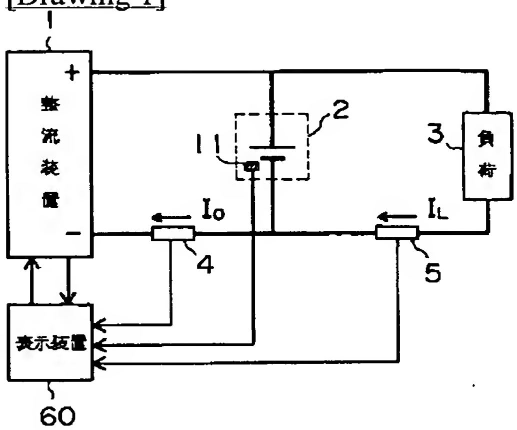
[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the direct-current electric supply system concerning this invention.
[Drawing 2] It is the one example block diagram of the capacity and the remaining time indicating equipment of this invention.
[Drawing 3] It is the characteristic curve sheet of the discharge current (C-Rate) and a discharge multiplier which presumes the remaining capacity in this invention.
[Drawing 4] It is the characteristic curve sheet of the capacity conversion time amount K based on the predetermined specification of a battery, and a charging time value T.
[Drawing 5] It is a discharge pattern Fig. based on the predetermined specification of a battery.
[Drawing 6] It is the example Fig. of a display displayed on a display means in an example of the result of an operation in this invention.
[Drawing 7] It is the block diagram of the conventional direct-current electric supply system.
[Drawing 8] It is the block diagram of the conventional capacity and remaining time indicating equipment.
[Description of Notations]
1 Rectifier
2 Battery
3 Load
4 Five Shunt
6 60 Display
7 I/O Means
8 1st Measurement Means
9 Operation Means
10 Display Means
11 Temperature Sensor
12 2nd Measurement Means
13 Conditioning Means
14 1st Storage Means
15 2nd Storage Means
16 Communication-Interface Circuit

[Translation done.]

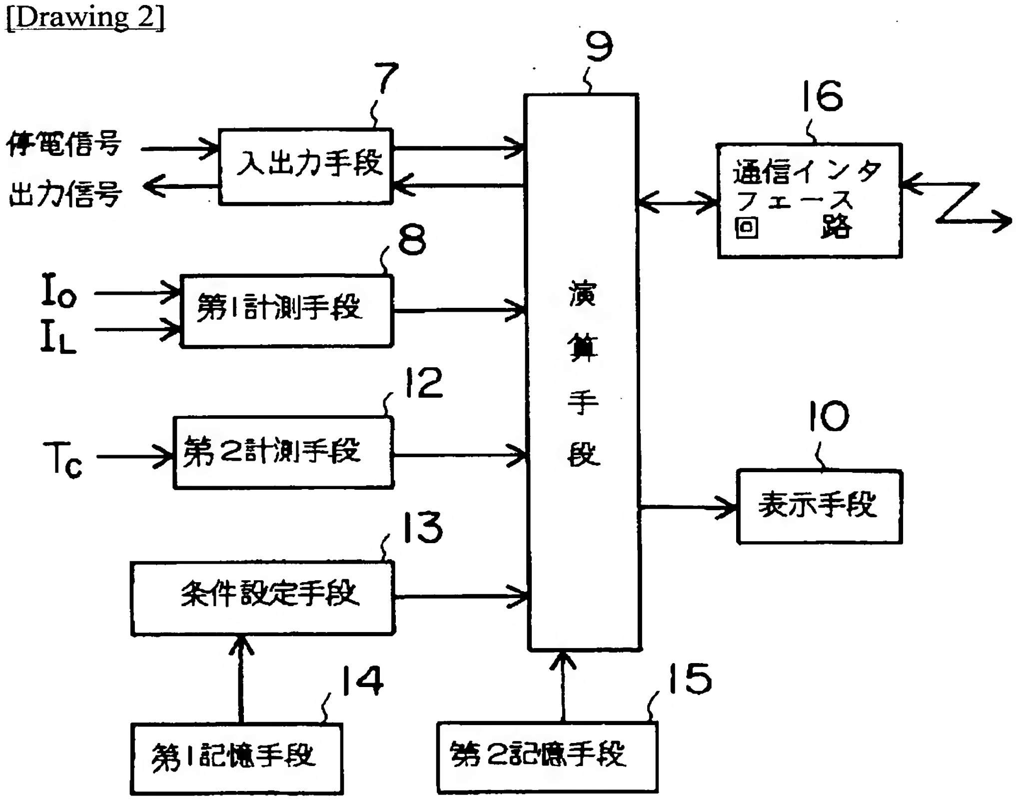
* NOTICES *

DRAWINGS

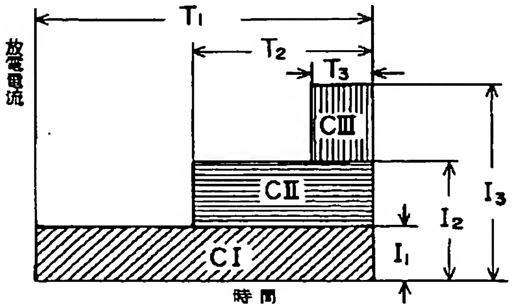
[Drawing 1]



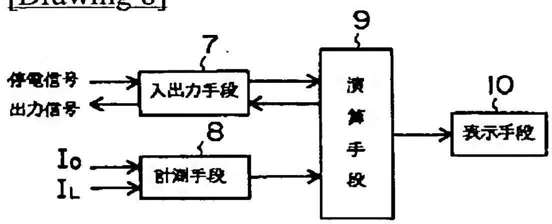
[Drawing 2]



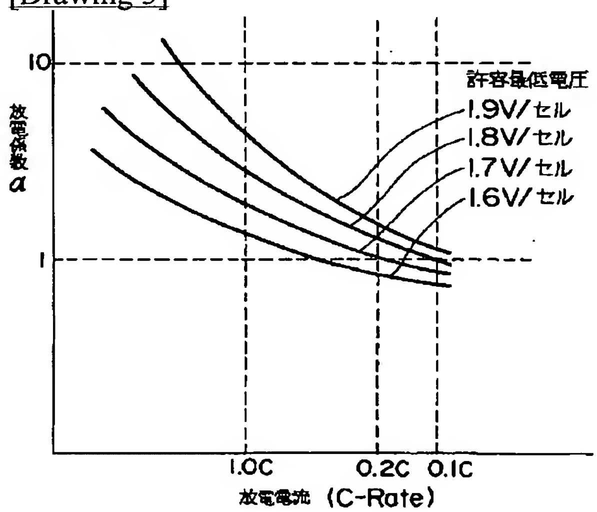
[Drawing 5]



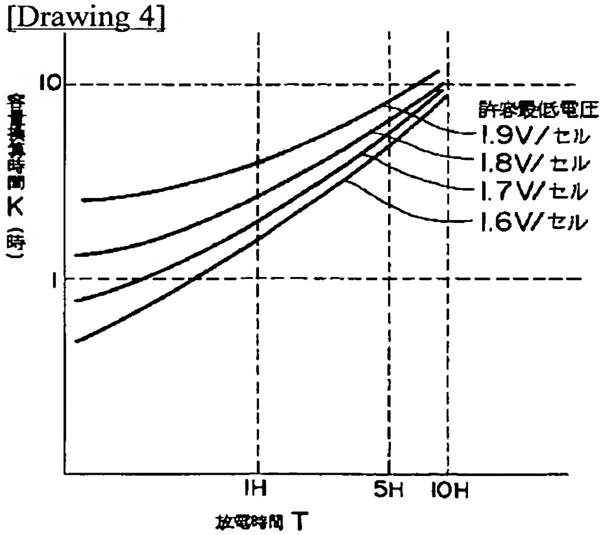
[Drawing 8]



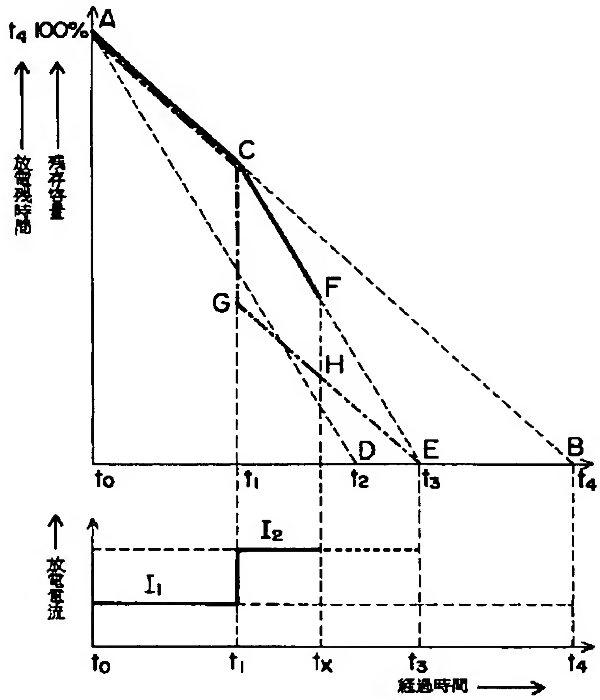
[Drawing 3]



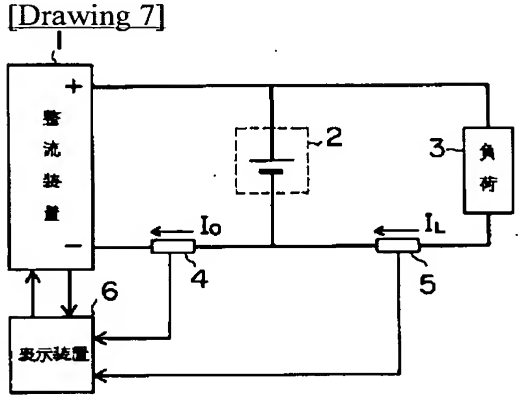
[Drawing 4]



[Drawing 6]



[Drawing 7]



[Translation done.]

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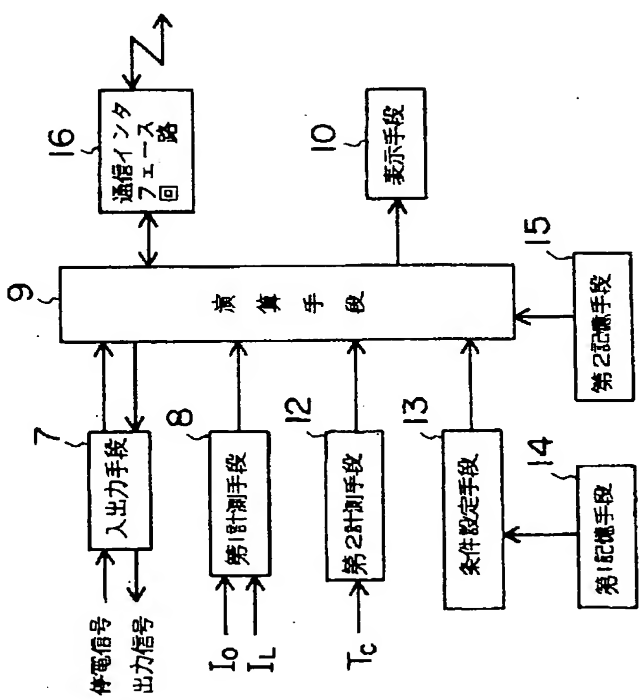
(54)【発明の名称】　蓄電池の容量・残時間表示装置

(57)【要約】

【目的】直流給電システムにおける蓄電池電流を検出し、残存容量及び放電時間を推定し表示する汎用性を有する装置を提供する。

【構成】整流装置１及び蓄電池２の仕様設定データ・テーブルを記憶する第１記憶手段１４より運用条件に合わせて初期設定できる条件設定手段１３と、蓄電池電流を計測する第１計測手段８と、温度を計測する第２計測手段１２と、動作時の放電電流と温度を検出し、所定の時間率放電に換算するための放電係数を記憶する第２記憶手段１５より放電電流に対する放電係数を求めて放電量を算出し、初期値の満充電時の容量より順次減算して残存容量をその時の放電電流と放電係数で除算して放電残時間を推定する演算手段９と、演算結果を表示する表示手段１０とを備えた表示装置。



【特許請求の範囲】

【請求項１】　整流装置と蓄電池より負荷に電力を供給する直流給電システムの表示装置であって、前記整流装置との間で信号の入出力を行う入出力手段と、前記整流装置の出力電流と負荷電流を計測する第１計測手段と、該第１計測出力で計算された出力電流と負荷電流との差より蓄電池電流を求める演算手段を備えた蓄電池の容量・残時間表示装置において、
前記蓄電池のケース温度を測定する第２計測手段と、
前記整流装置及び蓄電池の仕様設定項目とその設定値を集めたテーブル・データを記憶する第１記憶手段と、
前記第１記憶手段より選択して実際の運用条件に合わせて設定できる条件設定手段と、
蓄電池の所定の規格に定められた容量換算時間（Ｋ）と放電時間（Ｔ）特性を利用して、定格容量が既知である蓄電池を放電した場合の放電電流（Ｃ－Ｒａｔｅ）に対する放電係数を求めてテーブル・データとして記憶する第２記憶手段と、
前記第１計測手段及び第２計測手段より一定の単位時間毎に計測した蓄電池の放電電流と温度に対応する放電係数を前記第２記憶手段により求め、その値に前記放電電流と単位時間を乗じて所定の時間率放電に換算した放電量を算出して、満充電を初期値とする蓄電池容量から前記放電量を順次減算して残存容量を求め、満充電に対する百分率を算出し、かつ前記残存容量を前記放電係数とその時点の放電電流で除算し、動作条件における放電残時間を推定する演算手段と、
その演算結果を計測の単位時間毎に更新して表示する表示手段とを具備することを特徴とする蓄電池の容量・残時間表示装置。

【請求項２】　前記表示手段が前記演算手段による演算結果を計測の単位時間毎に更新して表示すると共に、演算結果を軌跡として図示表示することができる表示手段である請求項１記載の蓄電池の容量・残時間表示装置。

【請求項３】　前記第１及び第２計測手段による計測値並びに前記演算手段による演算データを、外部に転送するための通信インタフェース回路を備えた請求項１または２記載の蓄電池の容量・残時間表示装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は整流装置と蓄電池より構成され負荷に電力を供給する直流給電システムにおける蓄電池の残存容量及び放電残時間を推定し、その値を表示する表示装置に関するものである。

【０００２】

【従来の技術】図７は整流装置と据置蓄電池より構成され負荷に電力を供給する直流給電システムを示すもので、蓄電池２の充放電電流Ｉは、シャント４によって検出される整流装置１の出力電流I_0と、シャント５によって検出される負荷３の電流I_Lとの差を求めることにより得られる。この２つのシャント電流を容量・残時間表示装置６により単位時間毎に計測し、演算することにより蓄電池２の残存容量を知ることができる。従来の容量・残時間表示装置６（以下表示装置と略称する）の回路例を図８に示す。図８において、入出力手段７は整流装置１からの停電信号や故障信号を入力する回路、及び表示装置６に対して均等充電信号や警報信号を出力する回路である。計測手段８は前記シャント４及び５よりの検出信号をＡ／Ｄ変換器により読み取り、演算手段９により差分を求め演算することにより残存容量を求めることができる。また、入出力手段７により停電信号を検出した場合は、前記残存容量をシャント５より検出される負荷電流I_Lで除算することにより、その時点における放電残時間を求めることができる。そしてこの残存容量及び放電残時間はＬＣＤやＬＥＤ等の表示手段１０により表示するものである。

【０００３】

【発明が解決しようとする課題】しかしながら、図２に示す計測手段８で計測し、演算手段９によって得られる単位時間当りの放電量は蓄電池放電電流の大きさのみに依存する。即ち、実際の直流給電システムにおいては、図７に示す蓄電池２と負荷３との電圧降下の大きさにより、蓄電池許容最低電圧も変わり、定格容量を１００％放電することはできない場合がある。また、蓄電池は放電率により放電特性が著しく変化し、この放電特性も温度依存性が大きいことが知られている。従って、放電電流の大きさのみによる方法は誤差が大きく緊急時のバックアップ作業に及ぼす影響が大きいという問題がある。本発明は、これら問題点を解決し、蓄電池の残存容量及び放電残時間の推定精度の向上を図ろうとするものである。

【０００４】

【課題を解決するための手段】本発明は、整流装置と蓄電池より負荷に電力を供給する直流給電システムの表示装置であって、前記整流装置との間で信号の入出力を行う入出力手段と、前記整流装置の出力電流と負荷電流を計測する第１計測手段と、該第１計測出力で計算された出力電流と負荷電流との差より蓄電池電流を求める演算手段を備えた蓄電池の容量・残時間表示装置において、前記蓄電池のケース温度を測定する第２計測手段と、前記整流装置及び蓄電池の仕様設定項目とその設定値を集めたテーブル・データを記憶する第１記憶手段と、前記第１記憶手段より選択して実際の運用条件に合わせて設定できる条件設定手段と、蓄電池の所定の規格に定められた容量換算時間（Ｋ）と放電時間（Ｔ）特性を利用して、定格容量が既知である蓄電池を放電した場合の放電電流（Ｃ－Ｒａｔｅ）に対する放電係数を求めてテーブル・データとして記憶する第２記憶手段と、前記第１計測手段及び第２計測手段より一定の単位時間毎に計測した蓄電池の放電電流と温度に対応する放電係数を前記第

２記憶手段により求め、その値に前記放電電流と単位時間を乗じて所定の時間率放電に換算した放電量を算出して、満充電を初期値とする蓄電池容量から前記放電量を順次減算して残存容量を求め、満充電に対する百分率を算出し、かつ前記残存容量を前記放電係数とその時点の放電電流で除算し、動作条件における放電残時間を推定する演算手段と、その演算結果を計測の単位時間毎に更新して表示する表示手段とを備えたものである。

【０００５】

【実施例】図１は本発明による表示装置６０を図７に示した直流給電システムに用いた実施例であって、温度センサ１１により蓄電池のケース温度を検出している。図２は本発明による装置６０の回路構成を示したものであって、図８に示した従来の表示装置６のブロック図に第２計測手段１２，条件設定手段１３，第１記憶手段１４，第２記憶手段１５，通信インタフェース回路１６を追加し、放電時の残存容量及び放電残時間の推定精度の向上と、表示装置６０を定格の異なる整流装置に搭載可能とし汎用化を図ることを目的としたものである。なお、図８に示した計測手段８を、図２においては第２計測手段１２と区別するため、第１計測手段８と記載した。以下に図２の各機能について説明する。

【０００６】第２計測手段１２は温度センサ１１の検出信号が電圧信号の場合は増幅して、また、インピーダンス信号の場合は電圧信号に変換した後、Ａ／Ｄ変換する計測回路で蓄電池２の充放電状態の温度を監視する。条件設定手段１３は図１に示すシステムで運用されるシャント４及び５の定格値，蓄電池種別，定格容量及び許容最低電圧の各値を設定すると共に、蓄電池残存容量が減少し、警報出力動作を行う警報レベルを設定する回路部である。これらの設定値は現場の状況に合わせて設定されるので、汎用性が高く極めて広範囲に適用することができる。

【０００７】例えば図１に示したシャント４の定格電流値は蓄電池２の放電電流と負荷３への電流を加算した値で整流装置１の定格容量と共に決定され、シャント５の定格値は負荷電流の大きさで決定される。従って、蓄電池定格容量は、前記シャント５で検出される最大負荷電流が停電時に保持される時間によって決定される。このように多様化するシステムの設定条件に合わせて、キー・スイッチ及び表示器等により設定できる条件設定手段１３を設け、動作時に容易に初期設定できることは極めて有効である。そして、図２に示すようにこの設定された値に合わせて、第１計測手段８により読み取った値は＊

＊演算手段９により換算されて実測値となる。第１記憶手段１４は、前記条件設定手段１３の各設定項目毎の選択可能な範囲の値又は定格表示等の設定データ・テーブルであって、通常ＲＯＭに記憶されている。前記条件設定手段１３により選択され設定された後は不揮発性のＲＡＭ等に書き込まれ保持される。

【０００８】第２記憶手段１５は蓄電池種別毎に用意され、蓄電池の許容最低電圧，温度をパラメータとして定格容量に対する放電電流（Ｃ－Ｒａｔｅ）と放電係数αとの関係を示すデータ・テーブルである。このデータ・テーブルは図３に示した放電電流（Ｃ－Ｒａｔｅ）と放電係数特性を細分化しテーブル化したもので、許容最低電圧と蓄電池のケース温度をパラメータとして、通常ＲＯＭに記憶されている。図３の放電係数αはシャント５及び第１計測手段８により計測した放電電流が設置した既知の定格容量（通常は２５℃における１０時間率放電容量）に対して放電条件の厳しさを表す放電係数であって、放電率及び許容最低電圧が大きい程、また反対に温度が低い程大きくなる。この特性は蓄電池の放電特性曲線が示す傾向と一致している。

【０００９】次に、本発明の残存容量を推定するうえで重要な根拠となる図３の特性の算出方法について述べる。図４に示す特性は日本蓄電池工業会規格ＳＢＡ６００１「据置蓄電池の容量算出法」の容量換算時間Ｋと放電時間Ｔの標準特性図の一例であって、通常Ｋ－Ｔ曲線と呼ばれ、蓄電池の種別と蓄電池温度毎に用意され、必要とする放電時間に対応するＫ値に放電電流を乗ずれば必要な定格容量（１０ＨＲ）を簡単に求めることができるもので、一般によく用いられる。図３はこの図４に示したＫ－Ｔ標準特性を利用し、以下のように作図したものである。

【００１０】蓄電池容量が決定していて、一定の放電電流を流した場合、図４に示した横軸の放電時間Ｔの１０Ｈを１０時間率放電（１０ＨＲ）に相当する放電電流０．１Ｃとして表し、この時の図４の縦軸の容量換算時間Ｋ（約１０Ｈ）を横軸の放電時間１０Ｈで除算した値を放電係数αとして求め、他の放電時間についても同様に求めグラフ化したものが図３である。前記規格ＳＢＡ６００１では、放電電流が図５の放電パターンに示すようにＣＩ，ＣII，ＣIII と変化した場合、全体の放電に必要な蓄電池容量Ｃは（１）式によって与えられる。

【００１１】

【数１】

$$C = C_{I} + C_{II} + C_{III} = K_1 I_1 + K_2 (I_2 - I_1) + K_3 (I_3 - I_2) \quad (1)$$

【００１２】即ち、放電電流I_1，I_2，I_3の変化パターンに対して、蓄電池容量が放電電流の大きさに直接関係するのは第１項のI_1のみで、第２項及び第３項では（$I_2 - I_1$），（$I_3 - I_2$）の差が関係している。従って、放電パターンの変化がわからないと必要な容量は決定できないが、一般的には蓄電池の使用における最悪条件を考慮し、その時の放電電流の大きさを一定と仮定して決定される。また、（１）式を用いて、既知

の容量を放電させた場合の放電量の求め方は、図５の放電パターンに示した初期値の放電時間T_1が不明であるので、放電電流を測定するサイクルタイム毎に時間を加算して放電時間T_1を変更し、更に、その時の放電電流の変化に合わせて容量換算時間K値を選択し（１）式の第１項から計算し直すことを繰り返すことになるのが、この方法では計算が複雑で実用的でない。そこで図３に示した放電電流をＣ－Ｒａｔｅに換算し対応する放電係数αを求め、放電電流Ｉと計測のサイクルタイムとしての単位時間Δｔを乗じて、１０時間率（１０ＨＲ）に換算した単位時間当りの放電量（α×Ｉ×Δｔ）を求める。この放電量を１０ＨＲに換算した定格初期容量C_{10}（t_0）より、順次減算しこれを繰り返すことにより、任意の放電時刻t_nにおける１０ＨＲに換算した蓄電池残存容量C_{10}（t_n）を（２）式により求めることができる。

【００１３】

【数２】

$$C_{10}(t_n)=C_{10}(t_0)-\sum_{i=1}^{n}\alpha_i\times I_i\times\Delta t \qquad (2)$$

【００１４】ここでα_iは時刻t_0からt_nまでの間の任意の放電係数であって、この時の計測値である放電電流I_i，蓄電池温度および設定された許容最低電圧によって決定される値である。また、第２記憶手段１５に記憶されるデータ・テーブルは、前述のように図３を適度に細分化し、蓄電池種別および温度毎にまとめたものであって、任意の放電係数α_iがこのデータ・テーブルから直接求められる機会は少なく、テーブルの中間に位置することが通常である。このような場合は、放電電流I_iはＣ－Ｒａｔｅに換算された値、許容最低電圧，温度に関係する前後のデータ値が選び出され、これらの点を結ぶ直線近似計算が演算手段９によって行われ、最適な放電係数α_iが求められる。従って、残存容量C_{10}（ｔｎ）は精度的に充分高いと言える。

【００１５】C_{10}（t_n）の満充電に対する残存容量（％）は（３）式により表される。

【数３】

$$残存容量(\%)=C_{10}(t_n)/C_{10}(t_0) \qquad (3)$$

次に任意の時刻t_nにおける放電残時間t_dは、先ず（４）式により放電電流I_n時の条件における残存容量C_x（t_n）に戻すため（２）式で求めた容量をα_nで除算して求める。

【数４】

$$C_x(t_n)=C_{10}(t_n)/\alpha_n \qquad (4)$$

次に放電電流I_nで除算すると、放電電流I_nが時刻t_n以降も継続したと仮定した場合の放電残時間t_dを（５）式により求めることができる。

【数５】

$$t_d=C_x(t_n)/I_n \qquad (5)$$

一方、時刻t_nにおいて停電が回復したと仮定して、単位時間Δｔ後の時刻t_{n+1}における残存容量C_{10}（t_{n+1}）の変化は（６）式に示すように充電電流I_{n+1}に単位時間Δｔを乗じて加算する。

【数６】

$$C_{10}(t_{n+1})=C_{10}(t_n)+I_{n+1}\times\Delta t \qquad (6)$$

【００１６】このように蓄電池の充放電における演算処理は、図２に示す演算手段９により行われる。充電と放電の計算方法による差は残存容量の差となって表れるので、停電回復時の充電において、充電電流がある一定値、例えば０．０１Ｃ以下に減少してから充電タイマをスタートさせ、タイムアップにて例え残存容量が１００％に達していなくても、満充電の１００％として見なすことにより計算誤差の補正をすることが可能であり、これらの補正も演算手段９にて行う。上記により求められた残存容量及び放電残時間はＬＥＤ，液晶，ＥＬ等の表示手段１０によりサイクルタイムΔｔ毎に更新し表示される。

【００１７】表示手段１０が残存容量・放電残時間の変化の様子を図示するのに充分な分解能を有するドットピッチの表示手段を用いるなら、図６に示すような放電状態の軌跡（太い実線表示）と推定（鎖線表示）を演算手段９の指令により図示することができる。以下にこの図６に示されている概要について述べる。停電検出時刻t_0後、最初の計測サイクルタイムとしての単位時間Δｔにおいて、放電電流I_1について（２）式から（５）式までの計算を行い、放電残時間$t_d=t_4$なるＢ点を求めることができる。放電電流I_1は時刻t_1まで一定であるので、Ａ点とＢ点を結ぶ直線と時刻t_1の交点であるＣ点までは残存容量及び放電時間の軌跡はＡＣ間の直線に沿って減少する。そして時刻t_1において、蓄電池電流がI_2に増加した場合の軌跡は次のようになる。

【００１８】時刻t_0における放電電流I_1にてＢ点を求めたと同様の方法で、放電電流I_2についても求めると放電時刻t_2なるＤ点が求められる。点Ａ，Ｄ間を結ぶ直線をこの時の傾斜（t_4／t_2）を変えずに放電電流I_2への変化点である時刻t_1のＣ点まで平行移動し、横軸の経過時間と交わる点Ｅが時刻t_1における新しい放電残時間の推定値で前の推定時刻t_4から時刻t_3に変化し短くなる。任意の時刻t_xにおいて放電電流I_2は一定であるので、残存容量C_{10}（t_x）は点ＣとＥを結ぶ直線上のＦ点に求められる。一方、放電残時間

は今後も放電電流I_2が流れると仮定した場合のＥ点の時刻t_3が限界値で、この点を通り時間の経過は放電電流の大きさには依存しないので、直線ＣＢに平行移動すると時刻t_1にてＧ点が求められる。

【００１９】即ち、時刻t_1において放電残時間は（t_4-t_1）から（t_3-t_1）に急激に減少し、その後は時刻t_xまでは直線的に減少する軌跡を示している。またその後の推定される残存容量の変化は点Ｆ，Ｅを結ぶ鎖線で示され、放電残時間の変化は点Ｈ，Ｅを結ぶ一点鎖線で示される。もし、時刻t_x以降についても放電電流の変化が発生しても同様に求めることができ、これらを作図して表示する手段を有することはマン・マシン・インタフェースとして有益である。

【００２０】実例として前記時刻t_1における急激な残時間の変化は負荷電流の変動に追従して変化するので直感的で理解し易く、例えば、ある時刻にて放電残時間の値が期待する保持時間に達しない小さい値の場合は、負荷の重要度に応じて優先順位の低いレベルの負荷を順次切り放す等の方法が行われる。負荷の切り放しに追従して放電残時間は大きくなり、現状ままでよいのか、更に負荷の切り放しが必要なのか容易に判断できる。また、残存容量が条件設定手段１３により設定された警報レベルにどの時点で達するのか推定することも容易である。

【００２１】以上述べたように本発明による残存容量の求め方は規格ＳＢＡ６００１による容量算出法の（1）式に忠実に基づいてはいないが、近似的な方法として有効であり、そのうえ従来の電流と時間との積による算出方法に比較して極めて精度が向上している。前述したように、実際の蓄電池容量の決定は、放電パターンが一般的にはわからないので、最悪値の最大放電電流を一定と仮定した保持時間で決定しているので、（1）式による誤差を論じることは適正でなく、本発明は比較的簡単な計算でしかも前記規格ＳＢＡ６００１による考え方を取り入れているので精度的にも高く実用的である。

【００２２】

【発明の効果】本発明は標準的な直流給電システムに適用できるように整流装置の定格が異なっても、また、蓄電池種別や定格が異なってもそれらの条件設定できる手段を設けて登録，保持される。また、シャント４および５による２つの電流の計測値は設定値に対して定められた比率で換算され、蓄電池の種別，許容最低電圧，放電

率，温度に関する補正が演算手段９により行われるので、残存容量及び残時間表示に対する精度は極めて高い。また、高性能な表示手段を用いれば、上記の軌跡や予測値を図示することもできる。更に必要により通信インタフェース回路を設けることにより、これらの情報を監視するホスト・コンピュータに送信することも可能である。従って、近年、整流装置に蓄電池容量をモニタする機能が要求されることが多くなっているので汎用性を有する本発明の表示装置を直流給電システムに搭載することは極めて有益である。

【図面の簡単な説明】

【図１】本発明に係る直流給電システムのブロック図である。

【図２】本発明の容量・残時間表示装置の一実施例ブロック図である。

【図３】本発明における残存容量を推定する放電電流（Ｃ−Ｒａｔｅ）と放電係数の特性曲線図である。

【図４】蓄電池の所定規格に基づく容量換算時間Ｋと放電時間Ｔの特性曲線図である。

【図５】蓄電池の所定規格に基づく放電パターン図である。

【図６】本発明における演算結果の一例を表示手段に表示される表示例図である。

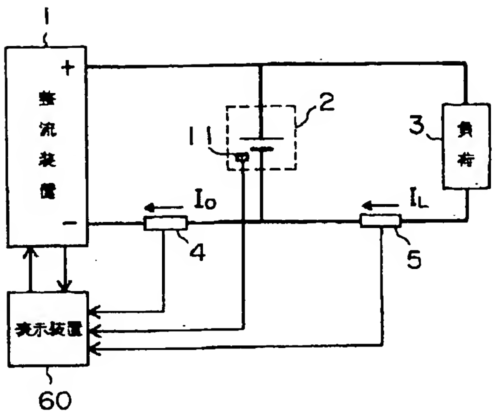
【図７】従来の直流給電システムのブロック図である。

【図８】従来の容量・残時間表示装置のブロック図である。

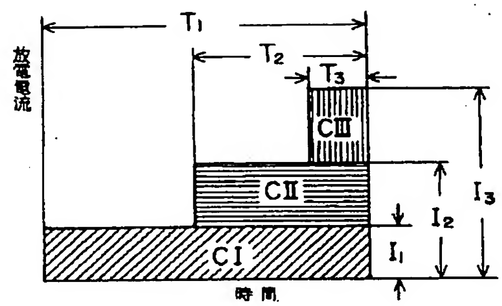
【符号の説明】

１　整流装置
２　蓄電池
３　負荷
４，５　シャント
６，６０　表示装置
７　入出力手段
８　第１計測手段
９　演算手段
１０　表示手段
１１　温度センサ
１２　第２計測手段
１３　条件設定手段
１４　第１記憶手段
１５　第２記憶手段
１６　通信インタフェース回路

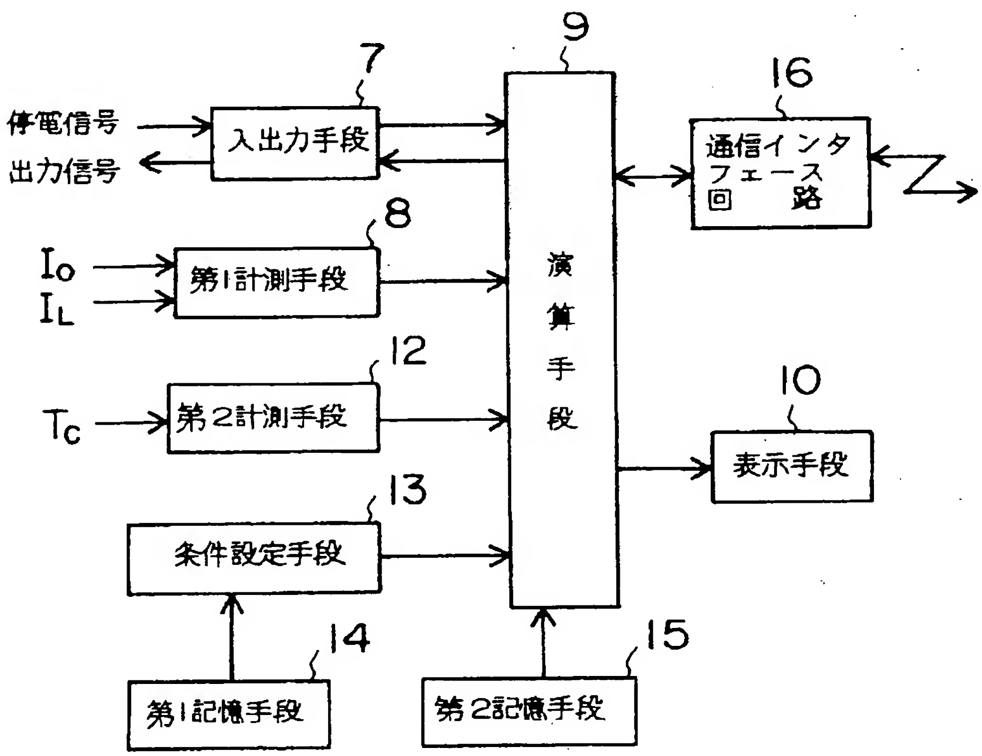
【図1】


1
整流装置
+
−
2
11
3
負荷
I_O
I_L
4
5
表示装置
60

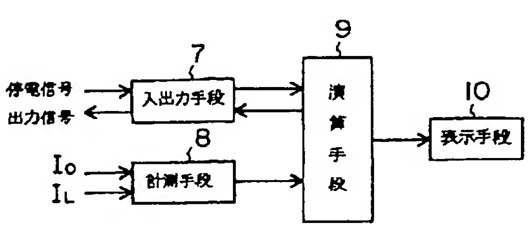
【図5】


T_1
T_2
T_3
放電電流
CⅢ
CⅡ
CⅠ
I_1
I_2
I_3
時間

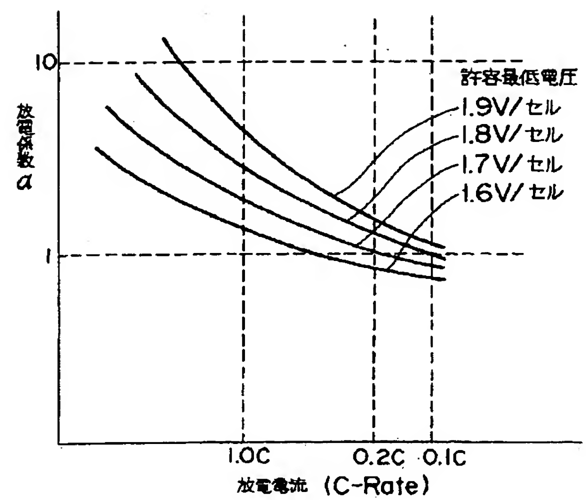
【図2】


停電信号
出力信号
7
入出力手段
9
演算手段
16
通信インタフェース回路
8
I_O
I_L
第1計測手段
12
T_C
第2計測手段
10
表示手段
13
条件設定手段
14
第1記憶手段
15
第2記憶手段

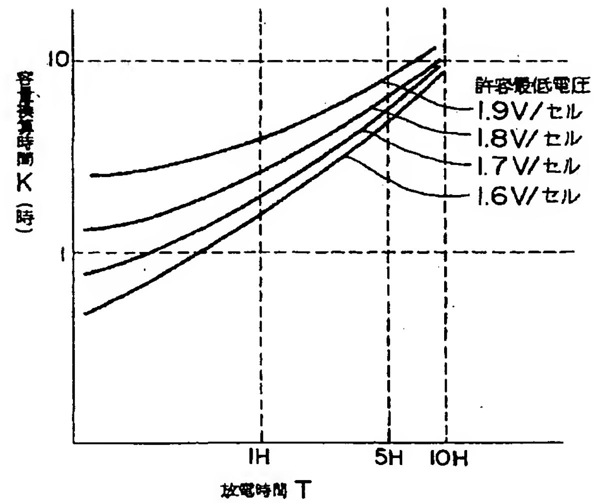
【図8】


停電信号
出力信号
7
入出力手段
9
演算手段
10
表示手段
8
I_O
I_L
計測手段

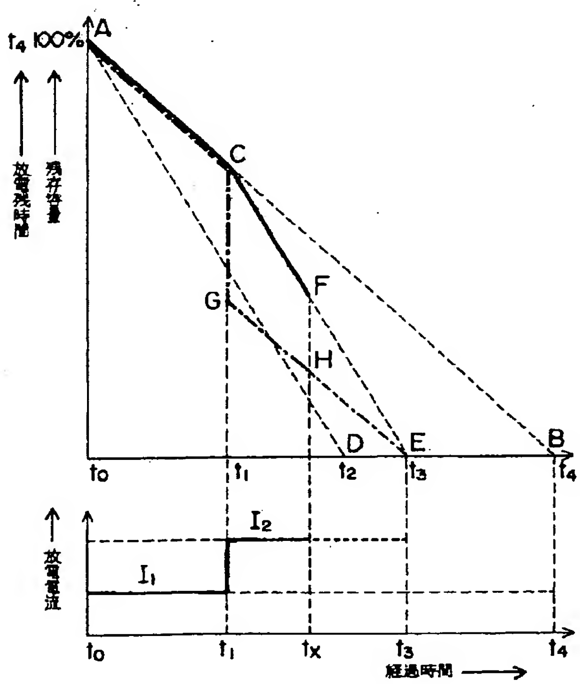
【図3】


10
1
放電係数 a
許容最低電圧
1.9V/セル
1.8V/セル
1.7V/セル
1.6V/セル
1.0C
0.2C
0.1C
放電電流（C-Rate）

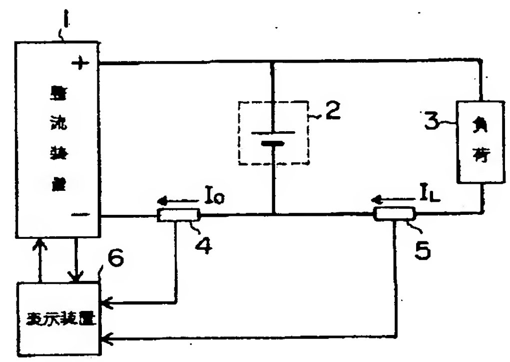
【図4】


10
1
容量換算時間 K（時）
許容最低電圧
1.9V/セル
1.8V/セル
1.7V/セル
1.6V/セル
1H
5H
10H
放電時間 T

【図6】


t4 100%
A
C
F
G
H
D
E
B
放電残時間
残存容量
to
t1
t2
t3
t4
I2
I1
放電電流
to
t1
tx
t3
t4
経過時間

【図7】


1
+
−
整流装置
2
3
負荷
Io
IL
4
5
6
表示装置